

10/581452

AP3 Rec'd PCT/PTO 01 JUN 2005

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DESCRIPTION

INFORMATION RECORDER, INFORMATION RECORDING  
MEDIUM, AND INFORMATION RECORDING METHOD

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TECHNICAL FIELD

The present invention relates to a technique for recording content in the form of time series data in an information recording medium such as an optical disk, 10 a magnetic disk, and an ID card, and reproducing a specified point of the recorded content.

BACKGROUND ART

It has been common to convert data 15 representing contents, such as moving picture data, still picture data, and text data, into time series data, and record the converted time series data into information recording media including, e.g., optical disks such as CD-R discs, CD-RW discs, CD-MRW discs, 20 DVD-R discs, DVD-WR discs, DVD-RAM discs, DVD+R discs, and DVD+RW discs, magneto optical disks such as MOs and MDs, magnetic disks such as HDs and FDs, and IC cards such as nonvolatile RAMs and flash ROMs. When recording the contents, an information recording medium suitable 25 for the content to be recorded is selected. Also, an

information recording device such as a CD drive, a DVD drive, an MO drive, an MD drive, an HD drive, an FD drive, or an IC card drive, applicable to the selected information recording medium is selected. The selected 5 drive is used for recording and reproducing the content.

FIG. 10 shows layout examples of an information recording medium for recording and reproducing time series data in linear addressing.

This information recording medium has a 10 recording/reproducing area divided into sectors of a fixed size. Areas shown in FIG. 10 are application level areas each having a size larger than the size of sectors. It is to be noted that the proportion of the size of the areas does not correspond to the proportion of the 15 actual data volume of the areas.

Referring to (a) of FIG. 10, a recording area 40 of the information recording medium includes a Lead-In area 41 at the top. The Lead-In area 41 is the area from which reading of information recorded in the 20 information recording medium is started when the information recording medium is loaded in an information reproducing device or an information recording/reproducing device. The Lead-In area 41 contains general information about the information 25 recording medium such as information about the

information recording medium itself and information about data layout.

The Lead-In area 41 is followed by a user recordable area 42 in which users can record content 5 represented by time series data and the like. The user recordable area 42 is the only area where users can record data.

The address of the top sector of the user recordable area 42 is zero, and is represented as 10 "LBA:0" (indicated by the arrow in FIG. 10). The user recordable area 42 has points called anchor points at addresses specified depending on file systems of operating systems.

The anchor points serve as marks for jumping 15 to another area over areas on the way in response to an instruction. The user recordable area 42 may have one or more anchor points. In the example shown in FIG. 10, the anchor points are provided at the start position of a content area 44 and a start position of a Lead-Out area 20 46.

A file system area 43 in the user recordable area 42 is for defining stored location of individual files and directories, the size, time, attribute, etc. The file system area 43 is followed by the content area 25 44 where content represented by the time series data is

recorded.

The content area 44 may be followed by a miscellaneous data area 45 where data excluding the content are recorded. The miscellaneous data area 45 is  
5 not necessarily required.

At the end, an area called as the Lead-Out area 46 is provided, which continues near the end limit of the information recording medium. The Lead-Out area 46 allows the information recording/reproducing device  
10 to recognize the end of a recording area 40 when recording/reproducing the content by receiving a light irradiated from an optical pickup and reflected by the information recording medium.

In many cases, the time series data  
15 representing the content occupy the greater part of the information recording medium. The areas provided in the information recording medium need to be continuous to each other. If there is non-recorded areas 47 as shown in FIG. 10 (b), regular information reproducing devices  
20 of reproduction-only type cannot reproduce the content. This indicates lowered compatibility of the information recording medium.

The time series data recorded in the information recording medium may be large-volume data  
25 containing, as the content thereof, images, sounds, maps,

an encyclopedia or the like. Such large-volume data are often provided with index information items (index data) for referring to segmentation points of the recorded content. The index information items may be, for example, 5 chapter images recorded together with a moving picture. The chapter images may be selected and prepared by, e.g., a producer of the moving picture or may be automatically created by the information recording/reproducing device, and are recorded as a part of data representing the 10 moving picture into a CD (CD) or a DVD (Digital Versatile Disc) in which the data representing the moving picture is recorded.

In many cases, the chapter images selected by the producer correspond to important scenes of the 15 moving picture. Accordingly, users can use the chapter images as the index information items and select one of the chapter images to playback the desired part of the moving picture.

However, the chapter images selected from the 20 moving picture by the producer and recorded as the index information items in the user recordable area cannot always be effective index information items to the users as the users may have different tastes and preferences.

A technique is disclosed in Japanese Patent 25 Laid-Open Publication No. 2001-76474 that sequentially

replays chapter images as index information items so as to allow users to quickly overview content and select a desired chapter image, and thus replays the desired part of the content.

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#### DISCLOSURE OF THE INVENTION

##### PROBLEMS TO BE SOLVED BY THE INVENTION

The disclosed technique allows users to see the chapter images as the index information items and quickly overview the content. However, the users need to select a chapter image corresponding to the desired part of the content. Accordingly, unless the users know well the whole content, the users cannot effectively use the chapter images to see the desired part. That is, the sequentially replayed chapter images do not serve as index information items for showing the users the digest of the content.

The above-described technique is for authoring index information items for content that is recorded in advance in an information recording medium and for recording the index information items into the information recording medium, and is not for recording index information items for content added to the information recording medium by a user or the content rewritten by a user.

In view of the above-described problems, the present invention aims to provide an information recording device, an information recording medium, and an information recording method that allow quickly 5 overviews content recorded in an information recording medium in advance and content recorded by a user and reproducing a selected part of the recorded content.

#### MEANS FOR SOLVING THE PROBLEMS

According to an aspect of the present 10 invention, there is provided an information recording device comprising a controller that adjusts recording conditions including a bit rate of time series data when recording content in an information recording medium, wherein the controller includes an index information 15 group creating unit that creates a time sequence index information group in which index information items extracted from the time series data for locating particular points of the content are arranged in time sequence of the time series data, and a reverse time 20 sequence index information group in which the index information items are arranged in reverse time sequence of the time series data; and an index information group recording unit that records the time sequence index information group and the reverse time sequence index 25 information group created by the index information group

creating unit into an area of the information recording medium different from an area where the time series data are recorded.

According to another aspect of the present invention, there is provided an information recording method that records content in the form of time series data in an information recording medium and reproduces particular points of the content, the method comprising:

an index information group creating step of creating a time sequence index information group in which index information items extracted from the time series data for locating the particular points of the content are arranged in time sequence of the time series data, and a reverse time sequence index information group in which the index information items are arranged in reverse time sequence of the time series data; and an index information group recording step of recording the time sequence index information group and the reverse time sequence index information group created in the index information group creating step into an area of the information recording medium different from an area where the time series data are recorded.

Since the time sequence index information group and the reverse time sequence index information group are created and recorded in the information

recording medium together with the time series data representing the content, a particular point of the content can be easily detected and reproduced even if the data volume is large.

5           It is preferable that the index information group creating unit acquire, as the index information items, plural image data items representing plural images that are extracted from the time series data every predetermined time. It is also preferable that  
10          when the content recorded in the form of the time series data is reproduced, the index information group creating unit extract, as the index information items, plural image data items representing plural images that are selected, according to a predetermined instruction, from  
15          images that change with time.

The former is advantageous in that index information items that suit users' preferences can be extracted. If ignoring users' preferences, the latter is convenient for busy users because the index information items are acquired while recording the content so as to have the index information groups recorded upon completion of recording the content.

If the index information group recording unit records the time sequence index information group and  
25       the reverse time sequence index information group into

an area adjacent to the area where the time series data are recorded, quick search and reproduction can be provided. If the time sequence index information group and the reverse time sequence index information group 5 are recorded in the following area adjacent to a content area, adding and rewriting of content can be accepted.

The time sequence index information group and the reverse time sequence index information group can be recorded in an area adjacent to a Lead-In area or a 10 Lead-Out area of the information recording medium. Since the position of the Lead-In area and the Lead-Out is obvious, searching operations can be further facilitated.

The index information group recording unit can record the time sequence index information group and the 15 reverse time sequence index information group into a predetermined area of an information recording medium, such as an IC card or a disk, different from the information recording medium in which the time series data are recorded. This can eliminate the need of 20 considering reproduction compatibility.

According to a further aspect of the present invention, there is provided an information recording medium in which content in the form of time series data are recorded, comprising: a first area in which the time 25 series data is recorded; and a second area in which a

time sequence index information group and a reverse time sequence index information group are recorded, the time sequence index information group containing index information items, which are extracted from the time series data for locating particular points of the content, arranged in time sequence of the time series data, the reverse time sequence index information group containing the index information items arranged in reverse time sequence of the time series data.

As the time series data representing the content and the index information groups of forward and backward directions of recording are recorded, a particular point of the recorded content can be easily reproduced.

15 ADVANTAGEOUS EFFECT OF THE INVENTION

According to an information recording device, an information recording medium, and an information recording method as embodiments of the present invention, an index information group of a forward direction according to the progress of recorded content and an index information group of the reverse direction are recorded. Therefore, even if the size of the content is large, it is easy to quickly overview the content recorded in advance and the content added by a user, and to locate and reproduce a particular part of the

recorded content.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a  
5 configuration of an optical disk recording device  
(optical disk drive) according to an embodiment of the  
present invention;

FIG. 2 is a block diagram showing a  
configuration of a computer system equipped with optical  
10 disk recording devices according to an embodiment of the  
present invention;

FIG. 3 shows formats in each of which an index  
area is provided at either side of a content area of an  
optical disk;

15 FIG. 4 shows formats in each of which an index  
area is provided at the top or the end of a content area  
of an optical disk;

FIG. 5 shows formats for storing time series  
data representing content and index information items  
20 thereof in different optical disks;

FIG. 6 schematically shows configurations of  
time sequence index information groups;

FIG. 7 is a flowchart showing a procedure of  
recording index information items after completion of  
25 recording time series data by a controller of an optical

disk drive or a CPU of a host computer;

FIG. 8 is a flowchart showing a procedure of simultaneously recording index information items and time series data by a controller of an optical disk

5 drive or a CPU of a host computer;

FIG. 9 is a flowchart showing a procedure of moving index information groups by a controller of an optical disk drive or a CPU of a host computer; and

FIG. 10 shows layout examples of an  
10 information recording medium for recording and  
reproducing time series data in linear addressing.

#### DESCRIPTION OF REFERENCE NUMERALS

1, 4	optical disk recording device
2, 5	input device
15	3, 6 display device
	7 optical disk
	8 editing/recording device
10	spindle motor
	11 optical pickup
20	12 tracking motor
	13 rotation control system
	14 tracking motor control system
	15 optical pickup control system
	16 signal processing system
25	17 nonvolatile memory

	18	buffer memory
	19	controller
	20	external interface
	21	host computer
5	22	A/D converter
	23	D/A converter
	24	ATA/ATAPI interface
	25	encoder/decoder
	26	ROM
10	27	RAM
	28	RTC timer
	29	CPU
	30	memory card slot
	31	memory card
15	32	memory card controller
	33	recording area
	40	Lead-In area
	41	user recordable area
	42	file system area
20	44	content area
	45	miscellaneous data area
	46	Lead-Out area
	47	non-recorded area
	48	index area
25	49	TLO area

50 anchor point  
51 zero (address)

BEST MODE FOR CARRYING OUT THE INVENTION

5 The following describes preferred embodiments  
of the present invention with reference to the  
accompanying drawings.

According to one embodiment of the present  
invention, when content that changes with time is  
10 converted to time series data and recorded in an  
information recording medium, a time sequence index  
information group in which plural user definable index  
information items are arranged in time sequence and a  
reverse time sequence index information group in which  
15 the index information items are arranged in reverse time  
sequence are recorded for easier search in place of  
conventional index information items.

Users can define the type, time intervals, and  
the number of the index information items with little  
20 restriction. The index information items can be created  
by storing a part of the content (e.g. image data or  
audio data) using timers of information recording  
devices.

For example, if a user wants to see a digest  
25 of the content in a forward direction (in time sequence),

an information recording/reproducing device sequentially reads the index information items in the time sequence index information group and sequentially reproduces the read index information items to show the digest in the  
5 forward direction.

If the user wants to see the digest of the content in a backward direction (in reverse time sequence), the information recording/reproducing device sequentially reads the index information items in the  
10 reverse time sequence index information group and sequentially reproduces the read index information items to show the digest in the backward direction.

Thus the user can smoothly see the details of the content in the form of the forward direction digest  
15 based on the time sequence index information group and the backward direction digest based on the reverse time sequence index information group, and can quickly reach the desired part of the content.

In the case of existing information recording  
20 devices and information reproducing devices, there is no problem in recording content into and reproducing content from, e.g., DVD video disks and video CDs for which standards define that a continuous recording area for time series data is provided. However, it is  
25 difficult to record index information items that suit a

user's preferences but that are not covered by the standards for the existing information recording devices and information reproducing devices, i.e., to add new user-defined index information items, into information recording media while maintaining recording and reproduction compatibilities with the existing information recording devices and information reproducing devices.

According to one embodiment of the present invention, separately from a recording area for the time series data, a recording area for recording and storing the index information items is provided in an information recording medium.

The index information items are located to precede or follow the time series data to allow continuous access to the index information items and the content, thereby preventing lowering of search performance due to discontinuous access.

Moreover, the time series data are recorded in the front part or the rear part of the recording area of the information recording medium so as to minimize influence of adding time series data. The location of the existing index area can be moved. When a user searches for a scene, the digest of the content can be replayed not only in the forward direction of the

progress of time but also in the backward direction and can be displayed smoothly. Thus the user can quickly reach the target scene or the target data, which indicates improved usability.

5           In the case where a user selects the backward direction digest, if the recording medium contains only the conventional time sequence index information group in which index information items are arranged in time sequence, the recording/reproducing device reads the  
10       index information items one by one from the time sequence index information group in the reverse order of the time sequence. Otherwise, the recording/reproducing device reads all the index information items and temporarily holds the read items in a memory and  
15       rearranges the items in the memory so as to enable backward playback.

For smoothly displaying the backward direction digest without irritating the user, in the case of reading the index information items one by one from the  
20       time sequence index information group in the reverse time sequence, the recording/reproducing device needs quick and high responsiveness and high specifications in terms of hardware. In the case of rearranging the index information items, a large volume primary memory is  
25       required. That is, both of the above options are

disadvantageous in terms of cost to manufacture hardware.

<Embodiments>

FIG. 2 is a block diagram showing a configuration of a computer system equipped with optical disk recording devices according to an embodiment of the present invention.

The upper optical disk recording device 1 is an easy-to-use device with high usability, and is provided with an input device 2. The optical disk recording device 1 can receive image and audio data from other media such as antennas, CATVs, and the Internet via a tuner or a network interface and can store the received data in an optical disk 7. It may be convenient if the optical disk recording device 1 is provided with a display device 3 such as a CRT or an LCD although one is not necessarily required.

The lower optical disk recording device 4 is embedded in a computer serving as a host computer or a personal computer, and receives instructions from an input device 5 including a keyboard and a mouse. The optical disk recording device 4 is also equipped with a display device 6 such as a CRT or an LCD. The optical disk recording device 4 is for more detailed editing and searching operations. The input device 5, including a remote controller, the keyboard, and the mouse, also

serves as a device for inputting and selecting index data. The optical disk recording device 4 can receive image and audio data from other media, such as the antennas, the CATVs and the Internet via a tuner and a 5 network interface, and can store the received data in the optical disk 7 with or without editing the data.

Both the optical disk recording devices 1 and 4 are connected to a host computer via an interface such as ATAPI.

10 An editing/recording device 8 shown in the center is a dedicated device used in studios or the like. In many cases, the editing/recording device 8 can perform complex authoring and is designed for use by professionals. The optical disk recording devices in 15 this embodiment can record time series data representing contents according to the place of use and according to the intended use.

FIG. 1 is a block diagram showing a configuration of an optical disk recording device 20 (optical disk drive) according to an embodiment of the present invention.

This optical disk drive corresponds to each of the optical disk recording devices 1 and 4, and is a recording device such as a DVD+RW drive that records 25 data into the optical disk (recording medium) 7 such as

a DVD+RW disc capable of recording and reproducing data. The optical disk drive comprises a spindle motor 10, a rotation control system 13 that controls rotation of the spindle motor 10, and an optical pickup 11 that 5 irradiates a laser beam L for recording data into and reproducing data from the optical disk 7.

The optical disk drive further comprises an optical pickup control system 15 that controls irradiation of the laser beam L of the optical pickup 11, 10 a tracking motor 12 that moves the optical pickup 11 in the radial direction of the optical pickup 11, a tracking motor control system 14 that controls rotation of the tracking motor 12, a signal processing system 16 that controls output of reproduction signals from the 15 optical pickup 11 and input of recording signals to the optical pickup 11, a nonvolatile memory 17 that stores various programs, and a controller 19 that controls the signal processing system 16 and the tracking motor control system 14 so as to record contents and index 20 information into the optical disk 7 by executing the programs stored in the nonvolatile memory 17.

The controller 19 is a microcomputer including a CPU, a register, and a RAM, and comprises an index data creating unit 19a for creating a time sequence 25 index information group in which index information items

for locating the addresses of particular points of time series data are arranged in time sequence of the time series data, and a reverse time sequence index information group in which the index information items 5 are arranged in reverse time sequence, and an index data recording unit 19b for recording the time sequence index information group and the reverse time sequence index information group created by the index data creating unit 19a into an area of the optical disk 7 different 10 from the area where the time series data are recorded.

The optical disk drive further comprises a buffer memory (cache memory) 18 that temporarily holds data such as data to be recorded into the optical disk 7 and data reproduced from the optical disk 7 and is used 15 as an area for temporarily holding data when the controller 19 performs various operations, and an external interface 20 that transmits data to and receives data from the externally connected host computer 21.

20 This optical disk drive loads data read from the optical disk 7 into the buffer memory 18 and then transfers the data to the host computer 21. Data transmitted from the host computer 21 is loaded into the buffer memory 18, converted into time series data with a 25 predetermined bit rate by the signal processing system

16 according to a control instruction from the controller 19, and recorded in the optical disk 7. Operations such as starting, suspending, and restarting recording and operations such as loading and ejecting 5 optical disks are controlled by the controller 19. The optical disk drive communicates with the host computer 21 via the external interface 20. More specifically, the host computer 21 issues commands, and the optical disk drive responds to the commands.

10 The controller may be integrated in the host computer 21. If the controller is integrated in the host computer 21, the optical disk drive and the host computer 21 are connected via an analog interface.

The host computer 21 comprises an A/D converter 22 that converts picture signals from the outside (the antennas and the networks) from analog to digital, an encoder/decoder 25 that performs compression and expansion of the AD converted picture signals (these operations may be performed by a CPU at high speed 15 instead), a D/A converter 23 that performs DA conversion (for output to a display device) using a PAL/NTSC video encoder, a RTC (real time clock) timer 28 that measures record time and indicates actual clock time so as to trigger index generation or to provide a content of 20 index, an ATA/ATAPI interface 24 that communicates with 25

the optical disk drive and a hard disk drive (not shown),  
the CPU 29, a ROM 26, and a RAM 27.

The RAM 27 is used as a buffer for work memory  
and image/audio data.

5           The ROM 26 stores programs for controlling the  
host computer and an operating system.

Although the ROM 26 may be a mask ROM, it may  
preferably be a nonvolatile flash ROM for facilitating  
version upgrade because the nonvolatile flash ROM allows  
10 collectively rewriting data stored therein.

The optical disk drive further comprises a  
memory card controller 32 for loading data, such as  
images taken by digital cameras, from a memory card 31  
loaded in a memory card slot 30, and for recording index  
15 data into the memory card 31.

The memory card 31 is typically a removable  
flash ROM, and can be used for sending and receiving  
digital data to and from not only personal computers and  
but also various other devices.

20           In place of the controller 19 of the optical  
disk drive, the CPU 29 of the host computer 21 may  
provide a function for creating a time sequence index  
information group and a reverse time sequence index  
information group, and a function for recording the time  
25 sequence index information group and the reverse time

sequence index information group into an information recording medium.

In that case, various programs (and various settings) are stored in the ROM 26, and the CPU 29 5 executes the programs so as to control the controller 19 for providing the above-described functions.

In this computer system, if these functions are provided by the optical disk drive, the controller 19 controls recording of index information items into 10 the optical disk 7. If the host computer 21 is also used to provide these functions, both the controller 19 and the CPU 29 control recording of the index information items into the optical disk 7.

For instance, when recording video data into 15 the optical disk 7 is started, a command for writing the created video data and predetermined chapter image data is issued from the host computer 21. Separately from this operation, the CPU 29 or the controller 19 generates index information items from frames of the 20 video data or data elements each indicating recorded time (e.g. recorded time based on Greenwich mean time and elapsed time from the recording start time) of the corresponding part of the video data, and records the generated index information into the optical disk 7 at 25 the right time during or after recording of the video

data.

The following describes formats used for recording the content represented by the time series data and the index information items into the optical disk 7 in the optical disk drive.

FIG. 3 shows formats in each of which an index area is provided at either side of a content area of the optical disk.

Referring to FIG. 3 (a), the top of a recording area 40 of the optical disk is a Lead-In area 41 in which general information about the optical disk such as information about the optical disk itself and layout information of recorded units located after the Lead-In area 41 are recorded. The Lead-In area 41 is followed by a user recordable area 42 in which users can record data. The address assigned to the top sector (or the top block) of the user recordable area 42 is zero "LBA: 0" 51. The user recordable area 42 includes a file system area 43 at the top thereof, in which the recorded location, the size, time, attribute, etc., of individual files and directories are defined, and an anchor point 50 next to the file system area 43.

The file system area 43 is followed by the content area 44 that stores the time series data representing the content. The content area 44 is

followed by an index area 48 that stores a time sequence index information group in which the index information items for locating the addresses of particular points of the time series data are arranged in time sequence and a 5 reverse time sequence index information group in which the index information items are arranged in reverse time sequence.

As can be seen, the time sequence index information group and the reverse time sequence index 10 information group are recorded in the index area 48 separately from the time series data recorded in the content area 44 in the optical disk 7. In the index area 48, the time sequence index information group may precede or follow the reverse time sequence index 15 information group.

Following another anchor point 50, a Lead-Out area 46 is provided at the end.

As shown in (a) of FIG. 3, in the case where no changes will be made to the time series data stored 20 in the content area 44, the index area 48 can be located immediately after the content area 44 and immediately before the Lead-Out area 46.

However, in the case where, for example, data are added to the time series data, the index area 48 is 25 moved or overwritten. In that case, as shown in FIG. 3

(b), the index area 48 is located immediately after the content area 44 and immediately before a TLO (Temporary Lead-Out) area 49. This format is used only for rewritable optical disks.

5           If, as shown in (c) of FIG. 3, the index area 48 is located (immediately) before the content area 44, the content area 44 does not need to be moved. As the size of the index area 48 is fixed, this format is useful for write-once optical disks. However, for  
10 improved compatibility, it is necessary to have data recorded in the Lead-In area 41 through the Lead-Out area 46 without discontinuity.

In the formats described above, the time sequence index information group may precede or follow  
15 the reverse time sequence index information group in the index area 48.

FIG. 4 shows formats in each of which an index area is provided at the top or the end of a content area of an optical disk.

20           In these formats, a time sequence index information group may precede or follow a reverse time sequence index information group in an index area 48.

The index area 48 may be located at the top of a user recordable area 42 immediately behind a Lead-In  
25 area 41 as shown in FIG. 4 (a), or may be located at the

end of the user recordable area 42 immediately ahead of a Lead-Out area 46.

The index area 48 located at the top or the end of the user recordable area 42 can be easily 5 detected, thereby improving responsiveness.

If, as shown in FIG. 4 (b), the index area 48 is located at the top of the user recordable area 42, the size of the index area 48 is fixed as in the case of (c) of FIG. 3. Accordingly, although the size is fixed, 10 ample index information can be provided if the index area 48 has a sufficient size.

If the index area 48 is located at the end of the user recordable area 42 as shown in (c) of FIG. 4, content can be easily added or rewritten. This improves 15 reproduction compatibility. This format is advantageous in that the size of both a content area 44 and the index area 48 can be increased. This format is advantageous especially for index information items that are frequently updated because addresses with smaller 20 numbers are assigned to more recent data. On the other hand, it may be slightly disadvantageous in performing search operations afterward because the index area 48 is extended in the negative direction upon increasing the size thereof.

25 In the case of this format, it is most

preferable to use fully formatted rewritable optical disks for enabling random access.

For example, discs such as DVD+RW discs and CD-MRW discs on which background formatting can be 5 performed provide enhanced convenience. Write-once optical disks may be used, but compatibility is added only after completion of recording.

As it is difficult to determine whether locating the index area 48 before the content area 44 is 10 better than locating the index area 48 after the content area 44, one of the two formats may be selected. It is preferable to allow each user to enable or disable the function because some existing recording devices cannot handle appearance of an unexpected index area.

15 FIG. 5 shows formats used for storing time series data representing content and index information items thereof in different optical disks.

As shown in (b), the index information items are recorded in an index area 48 in an optical disk (FIG. 20 5 (b)), and the content is recorded in a content area 44 in another optical disk (FIG. 5 (a)).

This system is disadvantageous in that plural optical disk drives are required or replacement of optical disks after recording of the content is required 25 for recording the index information. However, since the

layout is the same as that of reproduction-only optical disks, it is advantageous in that there is no need to consider compatibility.

This system is available if a memory card can  
5 be used separately from the main optical disk in which  
the content is recorded. In this format, a time sequence  
index information group may precede or follow a reverse  
time sequence index information group in the index area  
48.

10 The following describes a relationship between  
index information items and an index information group.

An index information group is a collection of  
index information items for locating addresses of  
particular points of time series data.

15 A time sequence index information group is a  
collection of index information items arranged in the  
order of time sequence of data portions of the time  
series data. The data portions result from dividing the  
time series data representing content by, e.g., certain  
20 time lengths (which may or may not be the same). Each of  
the data portions is image data representing an image.

The index information items are for locating the  
corresponding data portions based on addresses thereof.

A reverse time sequence index information group is a  
25 collection of the index information items which are

arranged in the reverse order of time sequence of the data portions.

The time lengths of the data portions of the time series data to be indicated by the index information items of the time sequence index information group may be different from the time lengths of the data portions of the time series data to be indicated by the index information items of the reverse time sequence index information group.

FIG. 6 schematically shows configurations of time sequence index information groups.

The index information items are data items for locating particular points of content recorded in the form of time series data. If the content is data representing a moving picture such as a movie or a television program, the index information items can be expressed in MPEG7 (Moving Picture Experts Groups 7) and can be recorded in various information recording media such as HDs (hard disks).

In a time sequence index information group, the index information items for locating particular points of the moving picture content (one movie or one television program) represented by a set of the time series data are arranged and stored in the order according to the progress of the moving picture. Each

index information item may contain, for example, a frame of the moving picture content or the recording time of a frame.

In FIG. 6, the lengths of the index  
5 information items schematically shown as blocks do not represent the data volumes of the index information items but schematically represent the corresponding portions of the content.

For example, in the case of a time series  
10 index information group G1 of FIG. 6 (b), index information items 1101, 1102, .... correspond to data portions (each having a unique address. This also applies to the following description) resulting from dividing time series data representing moving picture  
15 content by a time length of 120 seconds. That is, the index information items 1101 and 1102 correspond to a segment of the moving picture of 0 - 120 th second and a segment of the moving picture of 120 - 240 th second, respectively, resulting from dividing the time series  
20 data representing the moving picture content by a time length of 120 seconds.

In the case of a time series index information group G2 of FIG. 6 (c), index information items 1201, 1202, 1203, .... correspond to data portions resulting  
25 from dividing time series data representing moving

picture content by a time length of 60 seconds. That is,  
the index information items 1201, 1202, and 1203  
correspond to a segment of the moving picture of 0 - 60  
th second and pictures of 60 - 120 th second, and a  
5 segment of the moving picture of 120 - 180 th,  
respectively, resulting from dividing the time series  
data representing the moving picture content by a time  
length of 60 seconds.

In the case of a time series index information  
10 group G3 of FIG. 6 (d), index information items 1301,  
1302, 1303, .... correspond to data portions resulting  
from dividing time series data representing a moving  
picture content by a time length of 30 seconds.

If the time of the content is divisible by the  
15 specified time length, the resulting data portions have  
the same time length. However, if the time of the  
content is not divisible by the specified time length,  
the last data portion has a smaller time length than the  
other data portions. An index information item (11n, 11m,  
20 or 13o) is allocated to the last data portion having a  
smaller time length than the other data portions as in  
the case of the other data portions.

Each of the index information items 1101, 1102,  
..., 1201, 1202, ..., 1301, 1302, .... contains  
25 information for identifying the corresponding segment of

the moving picture, and image data of at least one frame contained in the corresponding segment of the moving picture. The information for identifying the corresponding segment of the moving picture indicates 5 the time of the corresponding segment relative to the entire content data, and contains, e.g., the start time and the end time.

For instance, the index information item 1101 contains time information such as the start time "0" and 10 the end time "120". The index information item 1202 contains time information such as the start time "60" and the end time "120". The index information item 1302 contains time information such as the start time "30" and the end time "60".

15           The image data contained in each index information item may be any one of frames within the corresponding segment of the moving picture. For instance, the image data may be a top frame or a middle frame (in the case of the segment of 0-120 th second, 20 the frame replayed in the 60 th second) of the corresponding segment.

In a reverse time sequence index information group, the index information items for locating particular points of the moving picture content (one 25 movie or one television program) represented by a set of

the time series data are arranged and stored in reverse order to the progress of the moving picture, i.e., in reverse time sequence.

For example, in the case of a reverse time sequence index information group containing the same index information items as the index information group G3 shown in FIG. 6 (d), the index information items 1301, 1302, 1303, 1304, . . . that correspond to data portions resulting from dividing the moving picture content by a time length of 30 seconds are arranged and stored in the order of . . ., 1304, 1303, 1302, and 1301.

If each index information item of an index information group contains image data of at least one frame, image data are read and reproduced from each index information item of the index information group. Thus, images of every time length used for division are sequentially displayed, and each of which is displayed for a predetermined time. For example, in the case of the time sequence index information group G2, images of every 60 second are sequentially displayed, each of which is displayed for a predetermined time.

In the case of the reverse time sequence index information group, if image data are read and reproduced at a predetermined time interval from each index information items, images are sequentially displayed in

reverse time sequence, each of which is displayed for a predetermined time.

FIG. 7 is a flowchart showing a procedure of recording the index information items after completion 5 of recording the time series data by the controller of the optical disk drive or the CPU of the host computer.

When recording the time series data is started or when the optical disk is loaded, the controller 19 (or the CPU 29) determines whether the optical disk has 10 been already formatted in Step (indicated by "S" in FIG. 7) 1. If the optical disk has not been formatted, then in Step 2 a Lead-In area of a recording area is recorded in the optical disk so as to format the disk (write-once optical disks do not require this process). Then the 15 processing proceeds to Step 3. In Step 3, the time series data are recorded in a content area of the optical disk.

At the same time, in Step 5, data portions 20 that can be used as index information items are extracted from the time series data that are recorded in Step 3, and the address of the locations where the data portions are to be recorded and the data portions are stored. The address and the data portions may preferably be stored in the RAM 27, a recording area having no 25 influence, or a different information recording medium.

In Step 4, it is determined whether an instruction for terminating the recording is issued from, e.g., a stop button. If a recording termination instruction is not issued, the processing returns to

5 Step 3. If a recording termination instruction is issued, the processing proceeds to Step 6 for creating the index information items. In the process of creating the index information items, the extracted data portions are processed according to user's instructions if possible.

10 Also, the time sequence index information group in which the index information items for locating particular points of the time series data are arranged in time sequence and the reverse time sequence index information group in which the index information items are arranged

15 in reverse time sequence are created. In Step 7, the created index information groups are recorded or updated in an index area of the optical disk.

In Step 8, a file system area 43 is recorded (created or updated) so as to allow other devices to

20 recognize the content and the index information groups, and then in Step 9 an anchor point 50 is recorded (created or updated). In Step 10, if there is a non-recorded area within the area from the address zero "LBA: 0" 51 to the maximum address where the recording

25 ends, the non-recorded area is recorded to form a

continuous area. Then in Step 11 a Lead-Out area 46 is recorded.

In Step S11, if the optical disk is a DVD+RW disc or a CD-MRW disc, a TLO area 49 is recorded 5 (created or updated) instead. Thus the procedure is completed.

The procedure described above is advantageous in that index information items can be recorded all at once at the end and therefore processing by users is 10 allowed. Therefore, index information items effective for each user can be easily created.

FIG. 8 is a flowchart showing a procedure of simultaneously recording the index information items and the time series data by the controller of the optical 15 disk drive or the CPU of the host computer.

When recording is started or when the optical disk is loaded, the controller 19 (or the CPU 29) determines whether the optical disk has been already formatted in Step (indicated by "S" in FIG. 8) 21. If 20 the optical disk has not been formatted, then in Step 23 a Lead-In area of a recording area is recorded in the optical disk so as to format the disk (write-once optical disks do not require this process). Then the processing proceeds to Step 23. In Step 23, the time 25 series data are recorded in a content area of the

optical disk. In parallel with this process, in Step 27,  
data portions that can be used as index information  
items are extracted from the time series data, and the  
extracted data portions and the address of the data  
5 portions are stored separately. The address and the data  
portions may preferably be stored separately in the RAM  
27, a recording area having no influence, or a different  
information recording medium.

Then the processing proceeds to Step 24 for  
10 creating the index information items. In the process of  
creating the index information items, the extracted data  
portions are processed according to user's instructions  
if possible. Also, the time sequence index information  
group in which the index information items for locating  
15 particular points of the time series data are arranged  
in time sequence and the reverse time sequence index  
information group in which the index information items  
are arranged in reverse time sequence are created. In  
Step 25, the created index information groups are  
20 recorded or updated in an index area of the optical disk.

In Step 26, it is determined whether an  
instruction for terminating the recording is issued from,  
e.g., a stop button. If a recording termination  
instruction is not issued, the processing returns to  
25 Step 23. If a recording termination instruction is

issued, the processing proceeds to Step 28. In Step 28, a file system area 43 is recorded (created or updated) so as to allow other devices to recognize the content and the index information groups, and then in Step 30 an 5 anchor point 50 is recorded (created or updated). In Step 30, if there is a non-recorded area within the area from the address zero "LBA: 0" 51 to the maximum address where the record ends, the non-recorded area is recorded to form a continuous area. Then in Step 31 a 10 Lead-Out area 46 is recorded.

In Step S31, if the optical disk is a DVD+RW disc or a CD-MRW disc, a TLO area 49 is recorded (created or updated) instead. Thus the procedure is completed.

15           In the case of hard disks or the like, as the recording speed and seek speed are very high, creation and recording of the index information items may be performed at the same time. However, in the case of a replaceable information recording medium such as optical 20 disks, as the recording speed and the seek speed are relatively low, it is preferable to create index information items as needed and record them all at once when the certain number of index information items are created.

25           This procedure is advantageous in that

recording the index information items will have been completed when the termination instruction is issued, and the waiting time from the issue of the termination instruction to ejection of the optical disk can be 5 reduced. Accordingly, this procedure is suitable for recording index information items related to clock time or time amount, e.g., index information items for quick look or a digest.

FIG. 9 is a flowchart showing a procedure of 10 moving index information groups by the controller of the optical disk drive or the CPU of the host computer.

In Step (indicated by "S" in FIG. 9) 41, the controller 19 (or the CPU 29) determines whether the optical disk has already been formatted. If the optical 15 disk has not been formatted, the processing proceeds to Step 49 in which error processing is performed. Thus, the operation is terminated.

If, in Step 41, the optical disk is determined to be formatted, then in Step 42 a time sequence index 20 information group and a reverse time sequence index information group are searched for. In Step 43, it is determined whether the index information groups are detected. If the index information groups are not detected, the processing proceeds to Step 49 in which 25 error processing is performed. Thus the procedure is

terminated.

If, in Step 43, the time sequence index information group and the reverse time sequence index information group are detected, then in Step 44 the 5 index information groups are copied. In Step 45 the index information groups are updated, and then in Step 46 a recordable portion for the index information groups is searched for. In Step 47, it is determined whether a recordable portion for the index information groups is 10 detected. If a recordable portion is not detected, processing proceeds to Step 49 in which error processing is performed. Thus the procedure is terminated.

If, in Step 47, a recordable portion for the index information groups is detected, then in Step 48 15 the time sequence index information group and the reverse time sequence index information group are recorded in the recordable portion. Thus the procedure is completed.

In other words, in the first step, it is 20 determined whether a recording operation has been already performed on the optical disk. Then, the time sequence index information group and the reverse time sequence index information group are searched for to confirm the presence thereof. If the index information 25 groups are detected, the index information groups are

copied and updated by a user or updated based on clock time. Then, a recordable portion for the updated index information groups is searched for and recorded into the recordable portion if any. If the index information  
5 groups themselves or a recordable portion are not detected, this is recognized as an error.

This operation may be required, for example, in the case where the index area 48 is overwritten or the index information groups as described with reference  
10 to FIG. 3, and in the case where the index information groups recorded in an area with the fixed size in the front part in the optical disk need to be moved to the rear part in the optical disk due to a need for a larger recording area.

15 According to the above-described embodiments, an index of content is prepared in addition to the content. Also, a time sequence index information group and a reverse time sequence index information group are provided. Therefore, various searching operations and  
20 operations of saving and using summaries that suit a user's preferences but that are not covered by the existing standards can be performed. Moreover, since specifications of main parts of hardware can be maintained at a low level, hardware can be provided to  
25 users at low price.

In addition, preparing an index of the content separately from the content and having both a time sequence index information group and a reverse time sequence index information group allows recording media 5 to have high compatibility with existing devices, high reusability, and high readability.

INDUSTRIAL APPLICABILITY

Information recording devices, information 10 recording methods, information recording media according to the present invention are applicable to video camcorders, digital editing devices, digital cameras, game consoles, and DVD players.